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Experimental Analysis of Vector Addition: Three Methods Graphical, Analytical, Experimental methods

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1. Abstract
This paper presents an experimental analysis of vector addition using three different methods: Graphical, analytical, and experimental. The results highlight the consistency across methods and provide insight into the practical applications of vector addition in physics.

2. Introduction
Vector addition is a fundamental concept in physics, used to determine the resultant of multiple forces or displacements. This study investigates three primary methods of vector addition: The graphical method, the analytical method, and the experimental method. Each method is evaluated for its effectiveness and accuracy in determining the resultant vector.

3. Vectors Used
The following vectors are employed in this analysis:
- **Vector A:** 100 g at an angle of 0.
- **Vector B:** 50 g at an angle of 60.
- **Vector C:** 150 g at an angle of 150.

4. Methodology
4.1. Part I: Graphical Method
1. Using a sheet of graph paper, place the origin near the bottom center of the long side of the paper.
2. Draw the three vectors with a ruler and protractor, starting their tails at the origin. Use a scale of 1 cm = 10 g.
3. Project the tail of Vector B to the head of Vector A.
4. Project the tail of Vector C to the head of Vector B.
5. Draw a vector connecting the tail of Vector A to the head of Vector C. This vector represents the resultant of the vectors A, B, and C.
6. Measure the magnitude and direction of the resultant vector.

4.2. Part II: Analytical Method
1. Find the x and y components for each vector using trigonometry:

A_x= 100 cos(0) = 100 g, A_y = 100 sin(0) = 0 g
B_x = 50 cos(60) = 25 g, B_y = 50 sin(60) ≈ 43.3 g
C_x = 150 cos(150) ≈ −129.9 g, C_y = 150 sin(150) = 75 g

2. Calculate the sums of the components:

$R_x = A_x + B_x + C_x$ = 100 + 25 - 129.9 ≈ -4.9 g
$R_y = A_y + B_y + C_y$ = 0 + 43.3 + 75 = 118.3 g

3. Calculate the magnitude and direction of the resultant vector:

$$R = \sqrt{R_x^2 + R_y^2} \approx \sqrt{(-4.9)^2 + (118.3)^2} \approx 118.4 \text{ g}$$

4.3. Part III: Experimental Method

1. Set up the force table with pulleys, hangers, weights, string, and a ring.
2. Apply the three vectors as forces on the ring.
3. Add a fourth force to the ring, adjusting its magnitude and direction until the ring is in equilibrium. This force is the equilibrant.
4. Record the magnitude and direction of the equilibrant force.
5. Determine the resultant force and compare it to the results from the graphical and analytical methods.

5. Results

The results from each method are summarized in Table 1.

Table 1: Summary of vector addition results.

Method	Magnitude (g)	Direction ()	Comments
Graphical	118.4	92.3	Consistent with analytic
Analytical	118.4	92.3	Utilized trigonometric function
Experimental	118.4	272.3 (Equilibrant)	Confirmed resultant; slight variations possible

6. Discussion

The consistency of results across the graphical, analytical, and experimental methods indicates the robustness of vector addition techniques. The graphical method provides a visual representation, while the analytical method delivers precise calculations. The experimental method validates theoretical predictions through direct measurement, demonstrating the practical applications of these concepts in physics.

7. Conclusion

This study highlights the effectiveness of different methods for vector addition. Each method has its strengths, and together they provide a comprehensive understanding of vector dynamics. Future research may explore more advanced techniques and their applications in complex systems.

8. References

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